COMPARISON OF THREE PCM PERFORMANCE EVALUATION SYSTEMS IN TAIWAN

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ABSTRACT: It has been debating on the performance evaluation of professional construction management (PCM) services since its introduction to Taiwan's construction industry more than a decade ago. Several evaluation systems were proposed by previous researchers**.** However, there has no comparison study been conducted for the feasibility, effectiveness, and appropriateness of these systems to the performance management (PM) of practical PCM services. This paper is intended for this end to compare the existing PCM performance evaluation systems in Taiwan. A real world design/build (D/B) building project was selected for case study. The result of case study concludes and compares the pro's and con's of the three systems. At the end, it recommends strategies for selecting the most appropriate PCM performance evaluation for PCM services.

Key words : PCM, performance management, case study, comparison.

1. INTRODUCTION

There are more and more professional construction management (PCM) projects in Taiwan due to three reasons: (1) the publication of Government Procurement Law in 1999 legalized the PCM services [1]; (2) more and more design/build (D/B) and build/operate/transfer (BOT) projects were contracted; (3) the "lean government" project of Taiwan significantly reduced the in-house engineers of public agents, construction management works previously performed by the engineers of the public engineering agent are now outsourced to engineering consultants. However, evaluation of the performance of PCM services is still a tough task due to the difficulty to define the physical output of PCM service. On the other hand, the evaluation of PCM services is important for the project owner. Most clients of PCM consultants are not engineering specialized or short of in-house engineers, they rely heavily on the expertise of PCM consultants but are incapable of effectively managing the process and results of PCM service.

Several PCM performance evaluation methods and systems were proposed by local researchers in Taiwan [2][3][4][16]. However, no comparison study was performed on these systems to evaluate the feasibility, effectiveness, and appropriateness for practical PCM projects. It is desirable for both the client and PCM consultant to select the most appropriate PCM evaluation system, not only to better control the process & results of the service, but also to improve the quality of the PCM service for mutual benefits of both sides.

This paper has been intended to compare three existing PCM performance evaluation systems in Taiwan, including (1) the PCM performance evaluation system (PPES) proposed by Yu and Hsin [2]; (2) the client satisfaction indicators (CSI) proposed by Perng [3]; and (3) the evaluation indicators for consulting firms (EIC) proposed by Chang and Fung [4]. The objectives of this research are: (1) comparing the existing PCM performance evaluation systems in light of the feasibility to practical project; (2) analyzing the effectiveness of the existing systems in terms of resource requirement and capability of problem identification; (3) selecting the most appropriate PCM performance evaluation system according to project characteristics and owner's objectives.

The rest of this paper will be presented in the following manner: the state-of-the-art of PCM performance evaluation is reviewed next; three existing PCM performance evaluation systems are described in Section 3; a real world D/B PCM project is selected for comparison case study in Section 4; the comparison results are discussed in Section 5; finally, conclusions and future works are summarized in Section 6.

2. STATE-OF-THE-ART

2.1 Performance Management (PM)

Performance management (PM) or performance measurement techniques have been developed since the 19th century [5]. The primary objective of PM was to evaluate and manage the performance of a business organization and the individuals in that organization. Early PM systems focused on planning and procedure control [6][7]. Later in the first quarter of the 20th Century, several PM systems based on financial indicators such as return on investment (ROI), discounted cash flow (DCF), residual income (RI), etc. were proposed [5][7]. Ever since, the financial ratio indicators have dominated the area of PM for evaluation of organization's business performance. The situation started to change in 1950's, as some researchers have found that the financial indicators do not reflect the most up-to-date information of the organization. There should be a substitute for financial indicators in performance measurement.

Several PM system were proposed after then to improve the financial indicators such as the Keegan et al.'s performance matrix [8] and Maskell's system based on world-class manufacturing measures [9]. However, the most significant development was Kaplan, R.S. and Norton's Balanced Scorecard (BSC) [10]. BSC is a quantitative performance evaluation system that consists of strategic objectives in four perspectives: financial, customer, internal process, and learning & growth. Each strategic objective can be evaluated by key performance indicators (KPI's) that are most representative for that strategic objective. The indicators or strategic objectives can be classified into leading and lagging categories. Financial indicators that are commonly used in the traditional PM system are considered as lagging indicators, since they can only be assessed after a period of operation is completed. Others are considered as leading indicators in different levels. The leading and lagging relationships of the indicators form a cause-effect network, which called "strategic map". The strategic map does not only depict the cause-effect relationship between indicators. It also implies the strategies for performance improvement. Moreover, BSC also emphasizes on "balance" among the four perspectives. That is, the business performance of an organization should take the performance of each perspective into account.

2.2 Performance Measurement in Construction

The performance measurement in construction has gained more and more intentions in the past decades due to declining productivity and competitiveness in construction industry. Robinson et al. [11] conducted a survey on the prevailing performance evaluation system in the UK construction industry and found that the top three options were Key Performance Indicators (KPI), European Foundation of Quality Management (EFQM) Excellence Model, and BSC. The KPI system was proposed by Egan in its report—"Rethinking construction"—to the Department of the Environment, Transport and the Regions of UK [12]. The objective of KPI was to identify the best practice in UK's construction industry. The EFQM Excellence Model is another performance evaluation system which descends from Total Quality Management (TQM). In EFQM Excellence Model, a self-assessment process is adopted to identify the key areas for performance improvement [13].

Bassioni et al. proposed a conceptual framework for measurement of performance in construction [14]. In their framework, the performance indicators were categorized into driving (leading) factors and results (lagging) factors. They also developed an IDEF0 system model for both driving and results processes of their system.

2.3 Performance Measurement for Project Management

Performance measurement for project management is conceived a difficult task as the scope of project management service is not physical and obvious [2]. Very little literature was discovered on this topic. Dainty et al. conducted an empirical evaluation of performance measures for contractor's project management and concluded nine successful factors [15]: (1) team building; (2) leadership; (3) decision-making; (4) mutuality and approachability; (5) honesty and integrity; (6) communication; (7) learning, understanding, and application; (8)self-efficacy; and (9) external relations. Each factor represents a group of relevant indicators. Totally 43 indicators were identified. Dainty et al. also pointed out that the successful factors of contractor's project management consist of both hard quantitative performance criteria and soft human performance criteria. However, their focus was on the contractor's viewpoint rather than from the PCM consultant's.

Some works by local researchers were found relevant to performance evaluation of PCM services. Yu and Hsin proposed a PCM Performance Evaluation System (PPES) based on BSC method [2]. The indicators of PPES were collected from a wide range of literature reviews, questionnaire surveys, expert interviews, and government regulations. The PPES provides performance evaluation systems for three stages in a project lifecycle. Perng developed a set of Client Satisfaction Indicators based on 26 questionnaires [3]. His system emphasized on the owner's perspectives of satisfactory PCM services. Chang and Fung also proposed a set of Evaluation Indicators for consulting firms (EIC) [4]. Their system focused on the project performance of construction phase. Indicators related to the other stages of a project were not included. In addition to the above three systems, Ho also proposed an evaluation system for project success called Level of Success of Project (LSP) [16]. Her system consists of three success components: (1) success on budget control; success on schedule control; and (3) success on function achievement. As LSP is relatively subjective system, the evaluation results might be significantly biased by the evaluator. As a result, it is not selected for comparison in the case study. The other three local performance evaluation systems will be described in details in the next section.

3. PCM PERFORMANCE EVALUATION SYSTEMS IN TAIWAN

In this section, the PCM evaluation systems selected for comparison study in the case project are described.

3.1 PCM Performance Evaluation System (PPES)

The PPES consists of 54 performance indicators in three stages of a project lifecycle: 17 indicators in Stage I, 15 indicators in Stage II, and 22 indicators in Stage III. The indicators of PPES are shown in Table 1.Due to limitation of the paper, for details PPES please refer to the reference of Yu and Hsin in the same proceedings [2].

Table 1. Indicators of PPES [2]

Perspect.	Strategic objective	Indicators in Each Stage		
		I	II	II
Financial	F_1 (Profitability)	IC_3, IC_4	MC_2, MC_3	FC_3, FC_4
	F_2 (Cost effectiveness)	IC_1, IC_2	MC_1	FC_2
Customer	C_1 (Service)	IS_3, IS_4	MS_3	FS_2, FQ_8
	C_2 (Satisfaction)	IQ_4, IQ_8	MQ_4, MQ_8	FQ_3, FQ_{12}
Internal Process	I_1 (PM)	IQ_5	MQ_5	FC_1, FQ_5, FQ_{10}
	I_2 (Process)	IQ_3	MQ_3	FQ_2, FQ_6, FQ_7
	I_3 (Expertise)	IS_2, IC_5, IQ_2	MS_2, MC_4, MQ_2	FS_1, FC_5, FC_6, FQ_1
	I_4 (Quality)	IQ_6	MQ_6	FQ_4, FE_1, FE_2,
Learning & growth	L_1 (Human resource)	IQ_7	MQ_7	FQ_9
	L_2 (Expertise)	IS_1, IQ_1	MS_1, MQ_1	FQ_{11}

3.2 Client Satisfaction Indicators (CSI)

The CSI indicators were identified by questionnaire surveys with 26 experienced project engineers and managers. The CSI system can be divided into two stages. Each stage consists of various categories and each category consists of several performance indicators. The two stages in CSI are (1) process stage—six categories with totally 39 performance indicators; (2) results stage—three categories with 19 performance indicators. The indicators of results satisfaction are Table 2; the indicators of process satisfaction are shown in Table 3.

Table 2. Indicators of Results Satisfaction in CSI [3]

Category	Indicator
I. Quality of service	1. Effectiveness of PCM QA system
	2. Quality of value engineering reports
	3. Effectiveness of review of construction plans
	4. Timeliness of review of construction plans
	5. Quality of schedule development
	6. Timeliness of schedule submittal
	7. Holding of regular coordinating meetings
	8. Completeness of meeting records
	9. Effectiveness of contracts and document manag.
II. Timeliness of service	1. Correctness of pay requests
	2. Timeliness of pay requests
	3. Completeness of supplements for pay requests
	4. Timeliness of completion inspection plan
	5. Timeliness of project completion report
	6. Completion timeliness
III. Effectiveness of finished work	1. Preparation of contracting and bid documents
	2. Control of awarding timeliness
	3. Effectiveness of awarding
	4. Control of contracting timeliness

Table 3. Indicators of Process Satisfaction in CSI [3]

Category	Indicator
I. Responsiveness	1. Regularity of consulting meetings
	2. Interface coordination and integration
	3. Change processing and advise
	4. Understanding of PCM work scope
	5. Expertise of construction management
	6. Auditing of completed work valuation
	7. Ability of handling warranty interface
II. Ability on schedule management	1. Schedule control
	2. Progress forecasting
	3. Management and coordination in progress
	4. Design progress control and coordination
	5. Progress auditing, analysis, and monitoring
	6. Constructability review
	7. Complete work inspection and transfer
III. Ability on financial analysis and administration support	1. Suggestion for financial plan
	2. Analysis of construction resource availability
	3. Development of preliminary budget plan
	4. Review of preliminary budget plan
	5. Bidding documents analysis
	6. Preparation of packaging and documents
	7. Help in contracting
	8. Help in selection of consultants and contractors
IV. Ability on document review	1. QA plan of PCM service
	2. Clarification of responsibility for all consultants
	3. Review of environmental impact assessment
	4. Review of design, drawing, and SPEC
	5. Review of payments for all trades
	6. Analysis of costs
	7. Review of construction and equipment budgets
	8. Re-check of all paid items
V. Experience	1. Ability in development of master plan schedule
	2. Analysis and suggestion of design requirements
	3. Review of interface in design and construction
	4. Document management and MIS application
	5. Analysis of disputes and claims
	6. Attitude of PCM
VI. Teambuilding	1. Effectiveness of regular meetings
	2. Ability of study and evaluation of alternatives
	3. Cooperation of team members

3.3 Evaluation Indicators for Consulting Firms (EIC)

The EIC system proposed by Chang and Fung [4] consists of 27 indicators, among which 8 are for company evaluation and 19 for project evaluation. In company level, the performance indicators can be further categorized as those for small, middle, and large size PCM consultants. These indicators are more relevant to financial performance. On the other hand, the project level indicators are more relevant to internal process performance. The limitation of EIC system is that it was developed for evaluating the consultant's service in preconstruction and construction phases. The PCM service performance of planning/design phases is neglected.

Table 4. Indicators of EIC

Category: Level	Category: Size of corp.	Indicator
Company	small, middle, large	1. Annual revenue
		2. Productivity per worker
		3. Capability of workers
		4. Training costs
	middle, large	5 Turnover rate of net value
		6. R&D expense
	small	7. Ratio of net worth
		8. Current ratio
Project	Project planning	1. Scheduling
		2. Cost estimating and VE
		3. Inconsistency/change
		4. Completeness
		5. Constructability
		6. Environment/ecology
	Construction	1. Scheduling
		2. Document review time
		3. Progress
		4 Installation inspection
		5. Completion timeliness
		6. Actual cost
		7. Testing and transfer
	Service	8. Communication w/ client
		9. Meeting effectiveness
		10. Response handling
		11. Knowledge and experience
		12. Document management
		13. Inspection and management methods

4. CASE STUDY

In this section, the three PCM performance evaluation systems described in the previous section is applied to a real world D/B PCM project for case study.

4.1 Case Background

The case project was a two-floor public parking garage construction project. The site area is 8,000 m2, floor area is 16,000 m2. The contracted project duration is 365-calendar day(a whole year) including planning, design, construction, and usage permission approval. Total project budget was USD 12.6 million. The project schedule was considered extremely tight. That's why the D/B contract and some innovative construction methods were adopted in the project.

4.2 Performance Evaluation

All three performance evaluation systems (PPES, CSI, and EIC) were applied to evaluate the PCM performance in the case project. The required data for performance indicators were collected in the period from 2004/1 to 2005/7 (19 months). The data were collected periodically on monthly basis. The evaluation results are shown in Figure 1~3. Figure 1 shows the evaluation of overall performance for PCM with the three systems. Figure 2 shows the evaluation of cost performance. Figure 3 shows the evaluation of schedule performance.

In Figure 1~3, the vertical axis represents the level of performance and the horizontal axis indicates the dates of data collection, i.e., "04/01" represents "January of 2004". The level of performance for various indicators in three performance evaluation systems was aggregated by summing up individual indicator values with weightings assessed by AHP method.

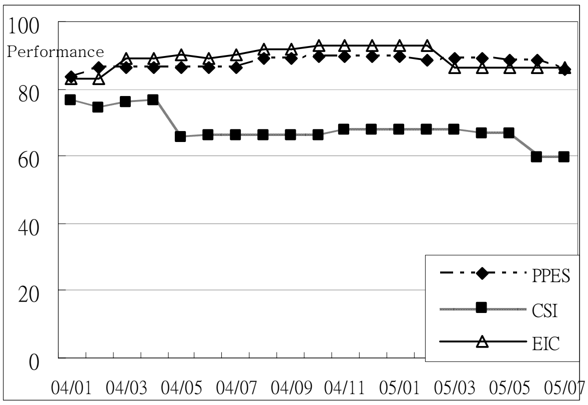

Figure 1. Overall performance of PCM

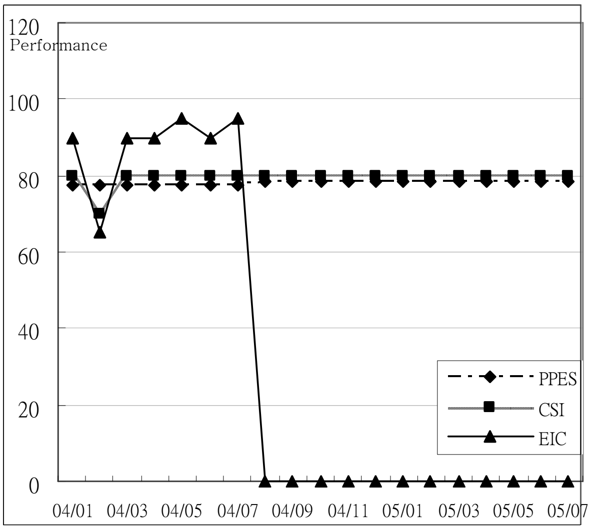

Figure 2. Performance of cost management

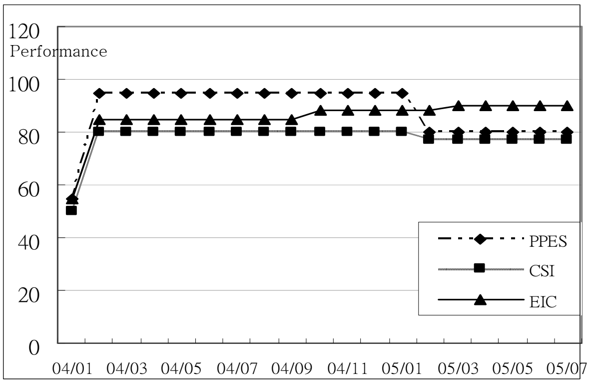

Figure 3. Performance of schedule management

4.3 Discussions on Case Study

It is found in Figure 1 that the results of PPES are similar to that of EIC, while the CSI depicts a different trend compared with the other two systems. By analyzing the historical data, it is found that the unit prices of rebar and premix concrete increased significantly in 2004/2. As a result, the awarding process was delayed for several works. It resulted in declining of client's satisfaction and lasted for the rest period of the project as all later awarding of works were delayed.

In cost performance evaluation, only cost related indicators are considered. It is found from Figure 2 that the EIC system failed in monitoring cost performance in the later stages of the project. It is due to that EIC lacks of cost related indicators in those stages. The trends of PPES and CSI were quite consistent. However, these two systems seem not sensitive to the cost performance variation.

In evaluating schedule performance, PPES shows discontinuity between different stages. The CSI is very sensitive to timeliness of work completion, however, it is assessed after the service is finished and thus not responsive to real-time situation that needs prompt response from the managers. The EIC system evaluates the schedule performance only when the project is complete, it does not reveal the intermediate performance information of PCM service during the process.

5. COMPARISON OF VARIOUS SYSTEMS

The case study results reveal some differences among the three systems. For PCM performance evaluation, three aspects are concerned most: the feasibility, effectiveness, and appropriateness. This section takes a deeper look into these aspects.

5.1 Feasibility

The feasibility of a PCM performance evaluation system represents the availability of required data for evaluation and the correctness of the information provided by the system. The key attributes considered are the feasibility of evaluation process and validity of evaluation results. To analyze the availability of required data, two criteria are useful: (1) the more indicators required the more difficult and expensive the system; (2) the more objective (quantitative) the indicators the more feasible the system. The result of feasibility comparison for the three systems is shown in Table 5, where the feasibility ranking for the three systems is: PPES>EIC>CSI.

Table 5. Comparison of feasibility of the three systems

System	No. different indicators	No. qualitative indicators	Feasibility
PPES	28	3	High
CSI	58	58	Low
EIC	27	13	Medium

5.2 Effectiveness

The effectiveness of a PCM evaluation system means the usefulness of the provided information to the objective of performance evaluation, i.e., improvement of PCM performance. Criteria for effectiveness judgment are not easy to define. Only qualitative judgment is performed. According to the case study, three aspects of PCM performance are monitored: overall, cost, and schedule. The result of qualitative comparison on the effectiveness of three systems is shown in Table 6. The cost effectiveness for the three systems is not very high as all three systems do not emphasize very much on the cost performance. Same situation was found in schedule effectiveness. However, the effectiveness of overall performance is better than individual aspect of performance, since all three systems emphasize very much on the coordination, communication, and other human-aspect performance of PCM services, which are not reflected in cost and schedule performance aspects.

Table 5. Comparison of effectiveness of the three systems

System	Effectiveness		
	Cost	Schedule	Overall
PPES	Medium	Medium	High
CSI	Medium	High	Medium
EIC	Low	Low	Medium

5.3 Appropriateness

The appropriateness of a PCM performance evaluation system implies the fitness of the selected system to the considered project. As a result, the appropriateness of PCM performance evaluation is highly project sensitive. Considering the availability of the required data, the type of organization and size of the PCM firm will also influence the selection of appropriate system. For large and well-organized PCM firms, PPES should be a proper selection for long term performance management. For serious project owners who are major PCM projects issuers, CSI is a proper system for post performance evaluation of PCM services in establishing pre-qualification database. EIC was developed for evaluation of consulting firms in construction phase. It was not intended specifically for PCM services.

5.4 Strategies for Selecting the Most Appropriate PCM Performance Evaluation System

By comparison of the three PCM performance systems, strategies for selecting the most appropriate system for the client or PCM consultant can be proposed. PPES seems to be first selection to the PCM consultant for self-improvement of its service performance. However, it contains 54 indicators and results in high implementation cost. The positive side is that most indicators of PPES are quantitative, and thus very suitable for computerization. The CSI was designed for the project owners. However, it is also most expensive and time-consuming to implement among the three systems. The EIC is suitable especially for construction phase. However, many indicators in EIC are lagging indicators that are not responsive to cost and schedule performance problems.

6. CONCLUSION AND FUTURE WORK

In this paper, three PCM performance evaluation systems were compared on their feasibility, effectiveness, and appropriateness for practical PCM projects. It is concluded that PPES is suitable for well-organized PCM firms to establish self-improving mechanism for their PCM services; The CSI was especially designed for project owners to reflect their concerns and preference of PCM services. It can be adopted by either the client or PCM consultant for post service evaluation. The EIC seems not very suitable for PCM performance evaluation. However, the performance indicators are quantitative and objective in the company level of EIC system. They are suitable for establishment of computerization.

Some directions deserve future research: (1) the effectiveness of PCM services needs more researches to clearly define; (2) cost of system implementation is not analyzed quantitatively, more in-depth studies are required; (3) strategies of selecting the most appropriate system considering project characteristics also worth of further research. Finally, by analyzing the three existing PCM performance evaluation systems, it is found that the ideal system is not yet available. Researchers are encouraged to pursue in this direction, too.

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